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Document Name: SAE J1128: Low Tension Primary Cable

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APPROVED

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LOW TENSION PRIMARY CABLE—SAE J1128

SAE Standard

Report of Electrical Equipment Committee approved November 1975.

1. Scope—This standard covers low tension primary cable intended for use at 50 V or less in surface vehicle wiring. Requirements for cable sizes 20 through 4 previously contained in SAE Standard, Low Tension Cable—SAE J558 and SAE Recommended Practice, Low Tension Cable Thermosetting Insulation—SAE J878, are included. Cable sizes 6 through 4/0 previously specified in SAE J558 are now included in SAE J1127.

2. Specification Types

2.1 Type GPT—General Purpose, thermoplastic insulated.

2.2 **Type HDT**—Heavy Duty, thermoplastic insulated.
2.3 **Type GPB**—General Purpose, thermoplastic insulated, braided.
2.4 **Type HDB**—Heavy Duty, thermoplastic insulated, braided.
2.5 **Type STS**—Standard Duty, synthetic rubber insulated.
2.6 **Type HTS**—Heavy Duty, synthetic rubber insulated.
2.7 **Type SXL**—Standard Duty, crosslinked polyethylene insulated.

3. General Specifications

3.1 **Conductors**—Conductors shall be bunched, concentric, or rope stranded as specified in the Appendix and shall be annealed copper wire in accordance with ASTM B-3. When tin or alloy coated wires are used they shall withstand the continuity test as specified under strand coating test (paragraph 5.1). A separator shall be used between the uncoated conductor and the synthetic rubber insulation. When coated conductors are used no separator is required. The cross sectional area of stranded conductors shall not be less than the values specified in Table 1.

Minimum conductor area for circular mils is based on 98% of total minimum strand area as specified in ASTM B-3. Minimum conductor area for mm^2 is based on 98% of minimum strand area. Before processing the final cable, the minimum strand area for metric strands shall not vary from the specified nominal by more than 1% expressed to the nearest .001 mm.

3.2 **Insulation**—Insulation shall be homogeneous in character and shall be placed concentrically within commercial tolerances about the conductor. Insulation shall adhere closely to, but strip readily from, the conductors leaving them reasonably clean and in suitable condition for terminating.

Insulation thickness shall be in accordance with the appropriate table for the various cable types. Variations in insulation wall thickness are permissible due to eccentricity. However, the minimum wall thickness at any cross section of a test specimen shall not be less than 70% of the nominal wall thickness of insulation specified in the appropriate table for the various cable types. The minimum wall thickness shall be measured with a pin dial micrometer exerting a force of 0.245 N with a mass of 0.025 kg and using a 0.043 in (1 mm) maximum diameter pin.

The physical properties of the insulation shall be as shown in Table 2.

3.3 Braid

3.3.1 GENERAL PURPOSE BRAID—When the construction includes a braided covering a closely woven braid of cotton or other fibrous material shall be applied over the insulation. All braided coverage shall be thoroughly covered or saturated with a firmly adhering compound that will present a finished appearance. Adjacent layers of cable when wound on a reel shall not stick to one another at any temperature under 140°F (40°C).

3.3.2 HEAVY DUTY BRAID—The braid shall be made up of one-half .028 in (0.7 mm) paper twine and one-half cotton yarn. The cable shall be braided so that all of the paper twine shall be in one direction and the cotton yarn in the opposite direction. The braid shall be finished or coated with a compound as specified in paragraph 3.3.1.

4. Cable Type Requirements

4.1 **Construction**—The conductors, insulation and braid shall be as specified in paragraph 3 for each type of cable.

4.2 **Test Requirements**—The test requirement for each type of cable shall be as indicated in Table 3.

4.3 **Dimensions**—The nominal wall thickness and maximum overall diameter of finished cable shall be as specified in Table 4.

5. Tests

5.1 **Strand Coating**—Tin test shall be conducted on strands prior to stranding and shall be conducted per ASTM B-33. Alloy coated wire shall conform to ASTM B-189.

TABLE 1—CONDUCTORS

SAE Wire[a] Size	Metric Wire[b] Size, mm^2	Minimum Conductor Area For Finished Cable	
		Cir Mil[a]	mm^{2b}
20	0.5	1072	.508
18	0.8	1537	.760
16	1.0	2336	1.12
14	2.0	3702	1.85
12	3.0	5833	2.91
10	5.0	9343	4.65
8	8.0	14810	7.23
6	13.0	25910	12.1
4	19.0	37360	18.3

[a] SAE wire size number indicates that the cross sectional area of the conductors approximate the area of American Wire Gauge for equivalent sizes.

[b] Metric wire size is the approximate nominal area of the stranded conductor. Metric dimensions are not direct conversion from circular mils.

See Appendix for various individual conductor constructions and nominal strand diameters.

TABLE 2—INSULATION PROPERTIES

Cable Types	Min Tensile Strength		Min Elongation
	psi	kPa	Percent
GPT HDT	2300	15860	125
GPB HDB	1000	6900	100
STS HTS	1600	11030	250
SXL	1500	10340	150

5.2 **Physical Properties (Insulation)**—Test samples of insulation that have been removed from the conductors shall be used. The conductor may be stretched for greater ease in removing it from the insulation. The sample may be tested as tube, slit-tube forms, or as dumbbells. The sample shall have marks placed upon it 2 in (50 mm) apart. The sample shall then be stretched at the rate of 20 in (508 mm) per min. The tensile strength shall be calculated upon the original cross section of the test sample before stretching. Physical tests shall be made at room temperature of 75 ± 5°F (21.1°C). For the purpose of these tests care must be used in cutting and obtaining samples of uniform cross section.

5.3 **High Temperature**—One in (25 mm) of insulation shall be removed from each end of a 24 in (610 mm) sample of finished cable. The sample shall be suspended around a cylindrical mandrel with a weight attached to each end of the sample. This condition shall be maintained in a circulating air oven. The mandrel size, weight, temperature and time shall be as specified in Table 5.

At the end of the above conditioning period the sample shall be removed from the oven and allowed to cool to room temperature. When cool the weights shall be removed and the sample bent in the reverse direction around the mandrel specified in Table 5 for the bend test at a rate not to exceed one complete turn per minute. The sample shall then be subjected to the Dielectric test as specified in paragraph 5.4.

5.4 **Dielectric Test**—One in (25 mm) of insulation shall be removed from each end of a 24 in (610 mm) sample of finished cable and the two ends twisted together. The loop thus formed shall be immersed in water containing 5% salt by weight at room temperature so that not more than 6 in (152 mm) of each end of the sample protrudes above the solution. After being immersed for five hours and while still immersed the sample shall withstand the application of 1000 V at 60 Hz between the conductor and the solution for one minute without puncture of the insulation.

5.5 **Cold Bend Test**—One in (25 mm) of insulation shall be removed from each end of a 24 in (610 mm) sample of finished cable. The temperature of the sample shall be lowered at a rate of 122°F (50°C) per minute until the specified temperature is reached. This temperature shall be maintained for three hours. While the sample is still at this low temperature it shall be wrapped around a mandrel for 180 deg at a uniform rate of one turn in 10 s. The temperature and mandrel size shall be as specified in Table 6. Either a revolving or stationary mandrel may be used. When a revolving mandrel is used fasten one end of the sample to the mandrel. The sample shall then be subjected to the Dielectric test as specified in paragraph 5.4.

5.6 **Flame Test**—A bunsen burner having a ½ in (13 mm) inlet, a nominal bore of ⅜ in (10 mm), a length of approximately 4 in (102 mm) above the primary inlets, equipped with a wing top flame spreader having a $\frac{1}{16}$ x 2 in (1 x 51 mm) opening fitted to the top of the burner shall be used. A 24 in (610 mm) sample of finished cable shall be suspended taut in a horizontal position within a partial enclosure which allows a flow of sufficient air for complete combustion but is free from drafts. The top of a 2 in (51 mm) gas flame with an inner cone one-third its height shall then be applied to the center of the suspended cable. The time of application of the flame shall be

TABLE 3—TEST REQUIREMENTS

Tests	Cable Types						
	GPT	HDT	GPB	HDB	STS	HTS	SXL
Strand Coating	x	x	x	x	x	x	x
Physical Properties	x	x	x	x	x	x	x
High Temperature	x	x	x	x	x	x	x
Dielectric	x	x	x	x	x	x	x
Cold Bend	x	x	x	x	x	x	x
Flame	x	x			x	x	x
Oil Absorption	x	x	x	x	x	x	x
Overload					x	x	x
Short Circuit					x	x	x
Pinch	x	x			x	x	x
Abrasion Resistance	x	x			x	x	x

TABLE 4—DIMENSIONS[a]

SAE Wire Size	Metric Wire Size, mm²	GPT				HDT				GPB			
		Nom Wall		Max Dia		Nom Wall		Max Dia		Nom Wall		Max Dia	
		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
20	0.5	.023	.58	.095	2.34	.036	.91	.120	2.95	.022	.56	.155	2.92
18	0.8	.023	.58	.100	2.50	.037	.94	.130	3.24	.022	.56	.135	3.43
16	1.0	.023	.58	.115	2.84	.040	1.02	.145	3.58	.022	.56	.145	3.68
14	2.0	.023	.58	.125	3.18	.041	1.04	.165	4.19	.022	.56	.165	4.19
12	3.0	.026	.66	.150	3.81	.046	1.17	.190	4.83	.027	.69	.195	4.95
10	5.0	.031	.79	.185	4.67	.046	1.17	.215	5.42	.031	.79	.230	5.84
8	8.0	.037	.94	.245	6.10	.055	1.40	.280	6.98	.037	.94	.301	7.65
6	13.0	.043	1.09	.305	7.72	.060	1.52	.340	8.60	.047	1.19	.360	9.14
4	19.0	.044	1.12	.375	9.32	.068	1.73	.420	10.44	.047	1.19	.437	11.10

SAE Wire Size	Metric Wire Size, mm²	HDB				STS and SXL				HTS			
		Nom Wall		Max Dia		Nom Wall		Max Dia		Nom Wall		Max Dia	
		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
20	0.5					.029	.74	.110	2.71	.036	.91	.125	3.08
18	0.8	.022	.56	.155	3.94	.030	.76	.120	3.00	.037	.94	.135	3.37
16	1.0	.022	.56	.170	4.32	.032	.81	.135	3.33	.040	1.02	.150	3.70
14	2.0	.022	.56	.190	4.83	.035	.89	.155	3.94	.041	1.04	.165	4.19
12	3.0	.027	.69	.230	5.84	.037	.94	.180	4.57	.046	1.17	.200	5.08
10	5.0	.031	.79	.255	6.48	.041	1.04	.210	5.30	.048	1.22	.225	5.67
8	8.0					.043	1.09	.245	6.10	.055	1.40	.270	6.73
6	13.0					.055	1.40	.335	8.47	.062	1.57	.350	8.85
4	19.0												

[a] Metric dimensions are not direct conversion from inches.

15 s for SAE wire size 10 through 20 and 30 s for SAE wire size 8 and larger. After removal of the bunsen burner flame the sample shall not continue to burn for more than 30 s.

5.7 **Oil Absorption Test**—One in of insulation shall be removed from each end of a 24 in (610 mm) sample of finished cable. The sample shall be immersed to within 1½ in (38 mm) from the ends of the insulator in a liquid containing equal parts of kerosene and SAE 10W engine oil at a temperature of 118–122°F (48–50°C) for a period of at least 20 h. The outside diameter of the cable shall not increase more than 15%. The sample shall then be bent around a mandrel as specified in Table 7, and then subjected to the Dielectric Test, paragraph 5.4.

5.8 **Overload Test**—In an ambient temperature of 75 ± 5°F (23.9°C) a 60 in (1524 mm) sample cable suspended in air or lying on a transite table top shall be subjected to an overload current sufficient to raise the conductor temperature to 400 ± 3°F (204°C) and to hold it there for a period of 30 min (thermocouple to be inserted into sample conductor stranding 18 in (457 mm) from one end). After the overload test cut 18 in (457 mm) from each end of the cable and discard. The remaining 24 in (610 mm) portion which was in

TABLE 5—HIGH TEMPERATURE TEST

Cable Type Test Conditions	GPT HDT GPB HDB 120 h/250 ± 2°F (121°C)				STS HTS 120 h/275 ± 3°F (135°C)				SXL 240 h/302 ± 3°F (150°C)			
SAE Wire Size	Mandrel		Weight		Mandrel		Weight		Mandrel		Weight	
	in	mm	lb	kg	in	mm	lb	kg	in	mm	lb	kg
20	4.5	114	1.0	0.45	4.5	114	1.0	0.45	0.50	12.7	1.0	0.45
18	4.5	114	1.0	0.45	4.5	114	1.0	0.45	0.50	12.7	1.0	0.45
16	6.5	165	1.0	0.45	6.5	165	1.0	0.45	0.50	12.7	1.0	0.45
14	6.5	165	1.0	0.45	6.5	165	1.0	0.45	0.75	19.0	1.0	0.45
12	6.5	165	3.0	1.36	6.5	165	3.0	1.36	0.75	19.0	3.0	1.36
10	10.0	254	3.0	1.36	10.0	254	3.0	1.36	1.00	25.4	3.0	1.36
8	10.0	254	3.0	1.36	10.0	254	3.0	1.36	2.00	50.8	3.0	1.36
6	10.0	254	6.0	2.72	10.0	254	6.0	2.72	3.00	76.2	6.0	2.72
4	10.0	254	6.0	2.72	10.0	254						

Bend Test Mandrel Dia.

Cable Type	GPT HDT GPB HDB		STS HTS		SXL	
SAE Wire Size	in	mm	in	mm	in	mm
20	3	76.2	3	76.2	1.0	25.4
18	3	76.2	3	76.2	1.0	25.4
16	3	76.2	3	76.2	1.0	25.4
14	6	152.4	6	152.0	3.0	76.2
12	6	152.4	6	152.0	3.0	76.2
10	6	152.4	6	152.0	3.0	76.2
8	6	152.4	6	152.0	6.0	152.4
6	10	254.0	10	254.0	6.0	152.4
4	10	254.0				

Note: Metric dimensions and weights are direct conversion from inches and pounds.

TABLE 6—COLD BEND TEST

Cable Type Test Conditions	GPT HDT GPB HDB 3 h/−40°F (−40°C)				STS HTS 3 h/−40°F (−40°C)				SXL 3 h/−60°F (−51°C)			
SAE Wire Size	Mandrel		Weight		Mandrel		Weight		Mandrel		Weight	
	in	mm	lb	kg	in	mm	lb	kg	in	mm	lb	kg
20	3.0	76	1.0	0.45	3.0	76	1.0	0.45	1.0	25.4	1.5	0.68
18	3.0	76	1.0	0.45	3.0	76	1.0	0.45	1.0	25.4	1.5	0.68
16	3.0	76	1.0	0.45	3.0	76	1.0	0.45	1.0	25.4	1.5	0.68
14	6.0	152	1.0	0.45	6.0	152	1.0	0.45	3.0	76.2	3.0	1.36
12	6.0	152	3.0	1.36	6.0	152	3.0	1.36	3.0	76.2	5.0	2.27
10	6.0	152	3.0	1.36	6.0	152	3.0	1.36	3.0	76.2	5.0	2.27
8	6.0	152	3.0	1.36	6.0	152	3.0	1.36	6.0	152.0	5.0	2.27
6	10.0	254	6.0	2.72	10.0	254	6.0	2.72	6.0	152.0	7.0	3.17
4	10.0	254	6.0	2.72								

the center of the original 60 in (1524 mm) shall then be subjected to the Dielectric test, paragraph 5.4.

5.9 Short Circuit Test (18 gage only)—Using six 36 in (914 mm) lengths and one 48 in (1219 mm) length of 18 gage cable strip 1 in (25.4 mm) of insulation from each end of the 48 in (1219 mm) length. Twist the six 36 in (914 mm) lengths around the 48 in (1219 mm) length with approximately a 4 in (102 mm) lay. Position so that 6 in (152 mm) of the 48 in (1219 mm) cable extends beyond each end. Tape into position using woven glass tape with ⅓ lap. Apply a constant 55 amp current to the center conductor of the bundle for three minutes. Turn off current and allow bundle to cool. Disconnect power source and test for short circuits between all conductors. Use 1000 V (rms) test voltage. There shall be no shorting of conductors and when the glass tape is removed from the bundle the individual wires shall be readily separated without tearing the insulation on the individual cables. This test is conducted to check the thermosetting properties of the insulation.

5.10 Pinch Test—One in (25 mm) of insulation shall be removed from one end of a 36 in (914 mm) sample of finished cable. The sample shall then be placed taut without stretching across a ⅛ in (3 mm) diameter steel bar and be subjected to the force of a weighted steel anvil. Increasing weight shall be applied to the steel anvil at a rate of 5 lb (2.27 kg) per min with a lever advantage of 10 at the moment the insulation is pinched through the ⅛ in (3 mm) diameter rod will contact the conductor and the test shall stop. The weight in the receptacle shall then be recorded. After each reading the sample shall be moved 2 in (51 mm) and rotated clockwise 90 deg. Four readings shall be obtained for each sample. Obtain an average by calculating the arithmetic mean of all those readings. The average shall define the pinch resistance of the cable under test.

5.11 Abrasion Resistance—One in (25 mm) of the insulation shown shall be removed from one end of a 36 in (914 mm) sample of finished cable. The sample shall then be placed taut, without stretching between the cable clamps as shown in military specification MIL-T-5438. Using the weight support bracket and weight specified in Table 10. The sample shall then be subjected to the abrasion test. After each reading the sample shall be moved 2 in (51 mm) and rotated clockwise 90 deg. Eight readings shall be obtained for each sample. Obtain an average by calculating the arithmetic mean of all readings. Discard all readings above the arithmetic mean and average the remaining readings. The average shall define the abrasion resistance of the cable under test. Values for individual cables are shown in Table 9.

TABLE 7—OIL ABSORPTION TEST

Cable Type	GPT HDT GPB HDB		STS HTS		SXL	
SAE Wire Size	Mandrel		Mandrel		Mandrel	
	in	mm	in	mm	in	mm
20	3.0	76.0	3.0	76.0	1.0	25.4
18	3.0	76.0	3.0	76.0	1.0	25.4
16	3.0	76.0	3.0	76.0	1.0	25.4
14	6.0	152.0	6.0	152.0	3.0	76.0
12	6.0	152.0	6.0	152.0	3.0	76.0
10	6.0	152.0	6.0	152.0	3.0	76.0
8	6.0	152.0	6.0	152.0	6.0	152.0
6	10.0	254.0	10.0	254.0	6.0	152.0
4	10.0	254.0				

Note: Metric dimensions and weights are direct conversion from inches and pounds.

Note: The Pinch Test apparatus shall be equivalent to that shown in Fig. 1. The minimum values for each cable type and size shall be as shown in Table 8.

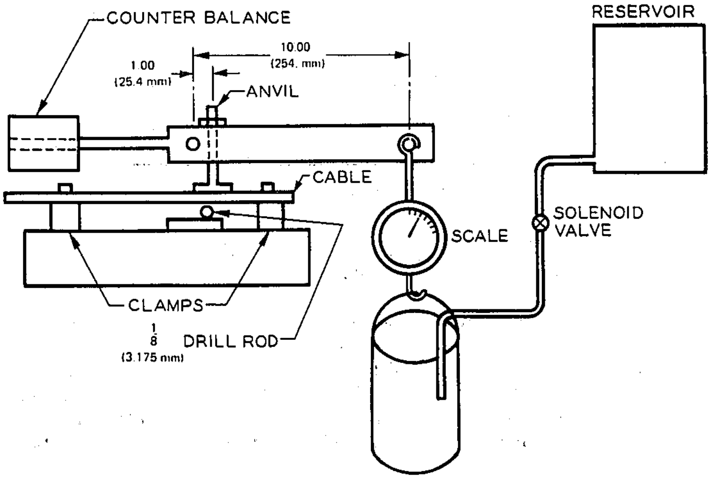

FIG. 1—PINCH TEST APPARATUS

6. Reference Information

6.1 Color Code

6.1.1 Recommended Colors—The color of the cables should match as closely as possible the following colors as set forth by "The Color Association of the U.S. Inc., 9th Edition."

6.1.2 Stripes—Where additional color combinations are required it is possible to apply color stripes. The stripes shall be applied longitudinally along the cable. Black or white stripes are recommended but other colors may be specified.

TABLE 8—PINCH TEST

Minimum Pinch Resistance

Cable Type	GPT		HDT		STS		HTS		SXL	
SAE Wire Size	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
20	5	2.3	9	4.1	8	3.6	10	4.5	11	5.0
18	6	2.7	10	4.5	8	3.6	10	4.5	16	7.2
16	6	2.7	13	5.9	8	3.6	10	4.5	18	8.2
14	8	3.6	15	6.8	8	3.6	10	4.5	20	9.0
12	8	3.6	18	8.2	8	3.6	10	4.5	25	11.0
10	10	4.5	24	10.9	8	3.6	10	4.5	30	14.0
8	11	5.0	32	14.5	8	3.6	10	4.5	35	16.0
6	15	6.8	43	19.5	8	3.6	10	4.5	40	18.0
4	27	12.2	54	24.5						

Note: Metric dimensions and weights are direct conversion from inches and pounds.

TABLE 9—ABRASION TEST (REQUIREMENTS)

Cable Type	GPT		HDT		STS		HTS		SXL	
	Minimum Resistance—Inches of Tape									
SAE Wire Size	in	mm	in	mm	in	mm	in	mm	in	mm
20	18	457	16	406	18	457	30	762	22	559
18	21	533	22	559	21	533	35	889	27	686
16	22	559	29	737	22	559	40	1016	30	762
14	12	305	15	381	12	305	18	457	14	356
12	16	406	20	508	16	406	22	559	18	457
10	20	508	27	686	20	508	30	762	24	610
8	25	635	46	1168	25	635	35	889	39	991
6	25	635	50	1270	25	635	60	1524	39	991
4	30	762	60	1524						

Note: Metric dimensions are direct conversion from inches.

TABLE 10—ABRASION TEST (CONDITIONS)

Cable Type	GPT			HDT			STS			HTS			SXL		
	Test Conditions														
SAE Wire Size	Br	lb	kg	Br	lb	kg	Br	lb	kg	Br	lb	kg	Br	lb	kg
20	A	1	0.45	B	3	1.36	A	1	0.45	B	1	0.45	A	1	0.45
18	A	1	0.45	B	3	1.36	A	1	0.45	B	1	0.45	A	1	0.45
16	A	1	0.45	B	3	1.36	B	1	0.45	B	1	0.45	B	1	0.45
14	B	3	1.36	B	4.25	1.93	B	3	1.36	B	3	1.36	B	3	1.36
12	B	3	1.36	B	4.25	1.93	B	3	1.36	B	3	1.36	B	3	1.36
10	B	3	1.36	B	4.25	1.93	B	3	1.36	B	3	1.36	B	3	1.36
8	B	3	1.36	C	4.25	1.93	B	3	1.36	C	3	1.36	B	3	1.36
6	C	4.25	1.93	C	4.25	1.93	C	4.25	1.93	C	4.25	1.93	C	4.25	1.93
4	C	4.25	1.93	C	4.25	1.93									

Note: Metric weights are direct conversion from pounds.

TABLE 11—TECA COLORS 9TH EDITION

Color	Nom.	Dark	Light
White	70003	70004	
Red	70180	70082	70179
Pink	70098	70099	70097
Orange	70072	70041	70071
Yellow	70205	70068	70067
Lt Green	70062	70063	70061
Dk Green	70065	70066	70064
Lt Blue	70143	70144	70142
Dk Blue	70086	70087	70085
Purple	70135	70164	70134
Tan	70093	70094	70092
Brown	70107	70108	70106
Gray	70152	70153	70185
Black	None	—	—

APPENDIX

Recommended Conductor Constructions (AWG Strands)

SAE Wire Size	Class III No. Strands/ AWG Size (in)	Class IV No. Strands/ AWG Size (in)
20	7/28 (.0126)	
18	16/30 (.0100)	65/36 (.0050)
16	19/29 (.0113)	
14	19/27 (.0142)	
12	19/25 (.0179)	
10	19/23 (.0226)	
8	19/21 (.0285)	
6	37/21 (.0285)	7 x 19/27 (.0142)
4	61/22 (.0253)	7 x 19/25 (.0179)

Recommended Conductor Constructions (Metric Strands)

SAE Wire Size	Metric Wire Size mm^2	Class III No. Strands/ mm Size
20	0.5	7/.31
18	0.8	19/.23
16	1.0	19/.28
14	2.0	19/.36
12	3.0	19/.45
10	5.0	19/.57
8	8.0	19/.71
6	13.0	37/.66
4	19.0	61/.63

Note: Stranding other than those shown above for both SAE and metric wire sizes are acceptable providing they meet the minimum conductor area specified in Table 1.